Specific Health Effects Associated with the Nerve Agent Acute Exposure Guideline Levels (AEGLs)

Background - AEGLs

Acute Exposure Guidelines Levels (AEGLs) are concentrations of a chemical in the air above which different health effects could begin to occur amongst the more sensitive (susceptible) members of the general population. AEGLs are being developed for hundreds of toxic industrial chemicals as well as chemical warfare agents. They are developed by the National Advisory Committee (NAC) for AEGLs, reviewed by the National Research Council (NRC) Committee on Toxicology, and are federal guidance for the assessment and management of short *one-time exposure incidents* (accidents or intentional terrorist attacks) involving releases of chemical gases. Unlike any other toxicity values for emergency response, AEGLs are established for multiple exposure periods ranging from minutes to hours (10 min, 30 min, 1 hr, 4 hr, and 8 hr).

The NAC derives AEGLs using a procedure recommended by the NRC[1]. This process begins with a set of generically defined health effect levels as represented below. Data for each chemical are evaluated and the types of health effects caused by a chemical are selected to fit in one of the 3 categories. The ultimate AEGL values that are derived are protective (safe-sided) estimates of where higher levels can begin to pose effects in some of the general population, including susceptible individuals such as children, persons with respiratory illness, and the elderly:

GENERIC DEFINITIONS OF AEGL LEVELS:

AEGL 1 – level above which non-disabling, reversible discomfort may begin to be noted.
AEGL 2 – level above which more serious effects may occur including possible long-lasting or escape-impairing effects.
AEGL 3 - level above which exposures may become life threatening or result in death.

These generic definitions, however, do not always provide adequate information to risk managers, as the actual health effects associated with individual chemicals may be less or more significant than assumed.

This Fact Sheet is designed to provide a more specific explanation of the actual types of health effects associated with the various AEGLs for Nerve Agents depicted in the Table on the next page.

Background - Nerve Agents

Nerve agents consist of a group of very toxic organophosphate chemicals specifically designed for military warfare. These include the agents code-named GA (Tabun), GB (Sarin), GD (Soman), GF, and VX. Other organophosphate chemicals include commercial insecticides such as Malathion®. These chemicals all cause similar effects on the human body by disrupting how nerves communicate and control muscles, glands, and organs. Though they cause similar effects, nerve agents are more toxic than commercial insecticides – so smaller amounts can cause effects of concern. Most of the nerve agents exist as liquids but some (such as GB) volatilize into the air on their own. VX is the least likely to become airborne, but in conditions involving explosions, it could vaporize and spread in the air. There are six chemical warfare agent (CWA) stockpiles that contain nerve agents in the U.S. The stockpiles were originally developed during the Cold War, and are now undergoing destruction. However, the potential for terrorist use may still exist after the US stockpiles are destroyed. As a result, many Federal, State, and local emergency planners have identified the need for acute toxicity guidelines for nerve agent to incorporate into emergency and homeland security programs.

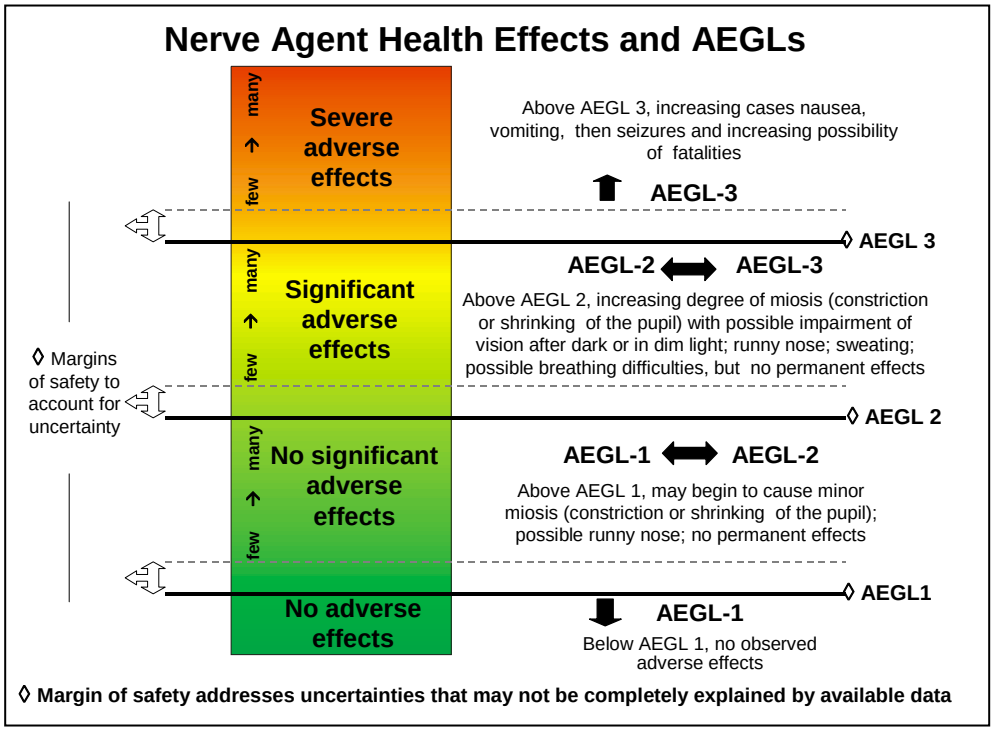
Health Effects Associated with Nerve Agent AEGLs

The first effect from vapor exposure to nerve agents is mild levels of miosis, a condition where contracting muscles in the eye cause the pupils to shrink. This is similar to the way the eyes react to bright light; but since the pupils of the eyes normally get bigger in darker environments, a person with miosis from chemical exposure may temporarily (hours) have some trouble seeing in darker environments. There are no distinct susceptible sub-groups to this effect (miosis), but at higher levels, miosis can become more significant, and eventually occur along with other effects such as breathing difficulties to which those with existing respiratory illness may be more susceptible. In the more likely exposure scenario of low nerve agent vapor concentrations only the surface tissues of the unprotected eye would be affected. Miosis alone is completely reversible without treatment, and it is not associated with long-term effects on any other systems or organs of the body. Key points associated with each AEGL are summarized below:

• Nerve Agent AEGL 1 is the estimated initial concentration *above which* some members of the general population could begin to experience mild miosis and/or slight runny nose. The estimated concentration for this effect is reduced by uncertainty factors (also known as “safety factors”) to provide a “margin of safety” (a factor of 10 or more) to ensure that the AEGL 1 is very protective. It is possible that no one, including more susceptible persons, would experience *any* effects at AEGL 1 concentrations. The Figure below shows how the margin of safety is incorporated into the AEGLs.

• Nerve Agent AEGL 2 is the estimated initial concentration *above which* some members of the exposed general population could begin to experience a more significant level of miosis with some runny nose, and possible shortness of breath. As with AEGL 1, the estimated concentration for this effect is reduced by safety factors to provide a margin of safety. This procedure provides a protective AEGL 2, which may result in some cases of miosis (which could last a few hours) and shortness of breath (which are likely to last only minutes after the exposure). *No long-term or permanent effects are expected to result from general public exposure at AEGL 2.*

• Nerve Agent AEGL 3 is designed to protect against severely incapacitating effects (e.g. effects which prevent persons from taking self-protective measures) to include severe nausea/vomiting, seizures and loss of consciousness. Without treatment, such severe effects could lead to death. As with the AEGL Levels 1 and 2, the estimated threshold for this effect is reduced by safety factors to provide a margin of safety. The result is a protective AEGL 3, which may result in some reversible incapacitation, but no deaths to the general public.



This figure depicts the gradation of expected proportion of people showing effects (few ➔ many) and the increasing severity in effects as air concentrations increase above each AEGL level. While the effects associated with the specific AEGL concentrations shown below have been critically evaluated, the exact degree of effects and number of persons affected at various concentrations *between* the AEGLs must be estimated using professional judgment.

AEGL Level	one time exposure duration	GA concentration (mg/m^3)	GB concentration (mg/m^3)	GD/GF concentration (mg/m^3)	VX * concentration (mg/m^3)
AEGL - 1	10 MIN:	0.0069	0.0069	0.0035	0.00057
	30 MIN:	0.0040	0.0040	0.0020	0.00033
	1 HR:	0.0028	0.0028	0.0014	0.00017
	4 HR:	0.0014	0.0014	0.00070	0.00010
	8 HR:	0.0010	0.0010	0.00050	0.000071
AEGL- 2	10 MIN:	0.087	0.087	0.044	0.0072
	30 MIN:	0.050	0.050	0.025	0.0042
	1 HR:	0.035	0.035	0.018	0.0029
	4 HR:	0.017	0.017	0.0085	0.0015
	8 HR:	0.013	0.013	0.0065	0.0010
AEGL - 3	10 MIN:	0.76	0.38	0.38	0.029
	30 MIN:	0.38	0.19	0.19	0.015
	1 HR:	0.26	0.13	0.13	0.010
	4 HR:	0.14	0.070	0.070	0.0052
	8 HR:	0.10	0.051	0.051	0.0038

References and Additional Information:

1. National Research Council (2001). *Standing Operating Procedures for Developing Acute Exposure Guideline Levels for Hazardous Chemicals*. Subcommittee on Acute Exposure Guideline Levels, Committee on Toxicology, National Research Council. National Academy Press, Washington, D.C.
2. National Research Council (2003). *Volume 3, Acute Exposure Guidelines for Selected Airborne Chemicals, Acute Exposure Guideline Levels for Hazardous Chemicals*. Subcommittee on Acute Exposure Guideline Levels, Committee on Toxicology, National Research Council. National Academy Press, Washington, D.C. www.nap.edu
3. *Basic Facts Regarding Chemical Standards and Guidelines*, USACHPPM 2006
4. *Frequently Asked Questions (FAQs) Regarding AEGLs and Their Application, USACHPPM 2006*
5. *Ready-Set-Act Fact Sheet: General Guidance Regarding AEGLs and CSEPP,* 2002

Additional Information/assistance: USACHPPM 410-436-1010.

The US Army Center for Health Promotion and Preventive Medicine (USACHPPM) is a support agency for the U.S. Army Surgeon General. Its mission is to provide worldwide technical support for preventive medicine, public health, and health promotion/wellness services into all aspects of America's Army and Army Community while anticipating and responding to operational needs and adapting to a changing world environment.